



Human Factors Recommended Approach for Approach Spacing Application During ADS-B OpEval2

- Review Test Ops Plan
- Propose Design Modifications
- Identify Additional Design Issues

Approach Spacing Concept

- Operational Purpose
 - Enhance flight crew spacing awareness during the approach phase of flight
 - Enable flight crews to set and acquire desired interval from lead aircraft at the runway threshold
- Key Evaluation Questions
 - 1 Does CDTI Enhance Visual Acquisition with Full and Mixed Equipage?
 - 2 Does CDTI Improve Spacing Performance During Initial Approach?
 - 3 Does CDTI/Advanced CDTI Improve Spacing Performance During Final Approach?

1. Visual Acquisition under Full and Mixed Equipage

OBJECTIVES

- Compare Pilot Use of CDTI for Vis Acq
 - Day Operations Full vs Mixed
 - Night Operations Full vs Mixed
- Evaluate Controller and Pilot Roles
 - Controller Responsible to Determine CDTI Utility
 - Pilot Responsible to Determine Use of CDTI
- Compare Radar vs ACD Displays

1. Vis Acq with Full/Mixed Equipage TEST OPS PLAN

- Three 1.5 hr periods (P1, P2: Day; P5: Night)
- First 45 min = Full Equip with 5 Aircraft
- Second 45 min = Mixed Equip with 9 Aircraft
 - 4 UAT, 3 Mode S, 2 Both
- Run Short Patterns with ATC Maneuvering
- All Low Approaches Except Last for Landing
- FAROA on Final; No Approach Spacing Issue

1. Vis Acq with Full/Mixed Equipage

ASSUMPTIONS

- Average 15 mins per Aircraft Pattern
 - About 14 visual acquisitions per period with full equipage (first lead aircraft has no TTF)
 - About 24 visual acquisitions per period with mixed equipage (Convairs will land after two patterns)
- With Only One Night Period, It is Safer to Task ATC with Determining CDTI Visibility
- One Controller Works Vis Acq Segment Each Period (Relief After Appr Spacing Segment)

1. Vis Acq with Full/Mixed Equipage Recommended Communications Protocols

- Current Test Ops Flight Profiles permit assessment of transition requirements; design should also include alternative communications protocols
- Recommend during Full Equipage (First 45 mins)
 - ATC calls TTF with Type and Callsign
 - Pilot calls TIS with Callsign if CDTI used
- Recommend during Mixed Equipage (Second 45 mins)
 - P1: Same as Full Equipage (Pilot Responsible)
 - P2, P5: ATC Responsible for CDTI Use
 - ATC calls Type if lead aircraft cannot be seen on CDTI
 - ATC calls Callsign if lead aircraft is visible on CDTI
 - Pilot calls TIS with Callsign if CDTI used

1. Vis Acq with Full/Mixed Equipage Recommended Responsibility for CDTI Use

	P1:Day	P2:Day	P5: Night
Full	Pilot	Pilot	Pilot
Mixed	Pilot	Controller	Controller

1. Vis Acq with Full/Mixed Equipage

MAJOR REMAINING DESIGN ISSUES

- Develop Aircraft Manipulation Heuristic for Visual Acquisition Task
- Develop Matrix of Aircraft Order to Ensure Each Aircraft will Acquire Traffic to Follow that Can and Cannot be seen on the CDTI
- Develop Design for ACD Evaluation
- Develop Questionnaire Items for Vis Acq
- Develop Data Analysis Plan

2. Initial Approach Spacing OBJECTIVES

- Evaluate If CDTI Improves Flight Crew Ability to Achieve and Maintain Desired Intervals for Initial Approach Spacing
 - Day Operations
 - Night Operations
- Evaluate Effects of CDTI Use on Flight Crews and Controllers

2. Initial Approach Spacing TEST OPS PLAN

- Four Periods (P2/P4: Day; P3/P5: Night)
 - P2 and P5 are 1.5 hours
 - P3 and P4 are 3 hours
- 5 CAA Aircraft Fly Outer Covey (STAR)
 - All have basic CDTI
- Flight Crews will Attempt to Close to Specified Spacing from Lead Aircraft
- Intercept Final at 20 NM

2. Initial Approach Spacing ASSUMPTIONS

- Each pattern (including the final approach segment and landing) will require 30 mins
- 45 Day Approaches (15 in P2 and 30 in P4)
- 45 Night Approaches (30 in P3 and 15 in P5)
- Spacing Criteria may Vary from P2/3 to P4/5
- Closure Occurs on Straight Legs, not Corners
 - DAMEN to MAIZE

2. Initial Approach Spacing RECOMMENDED MODIFICATIONS

- Current Test Ops Plan does not permit measurement or attribution of benefits to CDTI during initial approach
- Recommend designating one third of Approaches as “ATC Spacing” Patterns:
 - Ask ATC to Provide (Speed) Instructions indicating Distance Interval
 - Ask Flight Crew to Attempt Closing to Specified Interval Based on ATC Advisories
 - CDTI not used for spacing; used to prepare for CDTI use
- Evaluate CDTI vs “ATC Spacing”
 - Day: 30 CDTI and 15 ATC Spacing
 - Night: 30 CDTI and 15 ATC Spacing

2. Initial Approach Spacing

MAJOR REMAINING DESIGN ISSUES

- Determine Departure Spacing Interval
- Determine Spacing Criteria During STAR
- Determine Spacing Criteria at ELJAY
- Determine ATC Spacing Instructions
- Determine Which Runs Should be “ATC Spacing”
- Develop Questionnaire Items for Initial AS
- Develop Data Analysis Plan

3. Final Approach Spacing OBJECTIVES

- Evaluate If CDTI Improves Flight Crew Ability to Achieve and Maintain Desired Spacing Intervals at the Threshold
 - Day Operations
 - Night Operations
- Evaluate Whether Advanced Algorithms Enhance Ability to Achieve and Maintain Desired Spacing Intervals at the Threshold
 - Day Operations
 - Night Operations

3. Final Approach Spacing TEST OPS PLAN

- Five Periods (P1/P2/P4: Day; P3/P5: Night)
 - P1, P2, and P5 are 1.5 hours
 - P3 and P4 are 3 hours
 - All Final Approaches are 20 NM and to a Full Stop
- 5 CAA Aircraft from Outer Covey use Basic CDTI
- 3 Tech Center and a Collins GA Aircraft on Inner Covey use Advanced Algorithms

3. Final Approach Spacing ASSUMPTIONS

- All Final Approaches Begin at 20 NM
- Spacing Criteria may Vary Across Periods
 - 5 NM on P1/2/3?
 - 3 NM on P4/5?
- Target Spacing Entering Final is a Function of Threshold Criteria (probably +1 NM)
- Lead Aircraft will not Change Speed Within 5 NM
- 45 Day/45 Night Approaches for Basic CDTI
- 24 Day/12 Night Approaches for Advanced CDTI

3. Final Approach Spacing RECOMMENDED MODIFICATIONS

- Current Test Ops Plan only permits measurement of incremental benefit due to advance algorithms during final approach
- Collect relevant historical final approach spacing baseline data
- Evaluate Advanced vs Basic vs baseline
 - Day: 30 Advanced, 45 Basic, and TBD baseline approaches
 - Night: 15 Advanced, 45 Basic, and TBD baseline approaches

3. Final Approach Spacing

MAJOR REMAINING DESIGN ISSUES

- Determine Spacing Criteria on Entering Final
- Determine Spacing Criteria at Threshold
- Determine relevant Baseline data sets
- Develop Questionnaire Items for Final AS
- Develop Data Analysis Plan